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FCC REPORT OF RADIO INTERFERENCE

for

io Wave, Inc.
1010 Wisconsin Ave., NW Suite 215
Washington, DC 20007

FCC ID: NK4-2023336988

February 24, 1999

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NCL PROJ.# IOWAVE-463

1.0 Introduction

This report has been prepared on behalf of io Wave, Inc., to support the attached Application for Class II Change of a Part 15 Spread Spectrum Transmitter. The Equipment Under Test was the **ioLink 4.0 T2 Wireless Modem Transmitter.**

Radio-Noise Emissions tests were performed according to ***FCC Public Notice 54797, titled "Guidance on Measurements for Direct Sequence SST"***. The measuring equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Testing was performed at National Certification Laboratory in Ellicott City, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch. FCC acceptance was granted on May 26, 1993.

1.1 Summary

The io Wave, Inc. **ioLink 4.0 T2 Wireless Modem Transmitter** complies with the FCC limits (15.247) for a Direct Sequence SST.

2.0 Description of Equipment Under Test (EUT)

The EUT Features:

+ 25 dBm RF Output

2412 to 2452 MHz Freq. Range

20 MHz Channel Bandwidth

2-Channels Duplex Operation

DQPSK6-SS Modulation

Data Rate - (T2)

3.0 Test Program

This report contains measurement charts and data as evidence for the following tests performed:

1. (15.247) Peak RF output power.
2. (15.247) Power Spectral Density (3kHz Bandwidth).
3. (15.247) Field strength of harmonics and spurious out-of-band emissions.
4. (15.247) RF Antenna Conducted of harmonics and spurious out-of-band emissions.
5. (15.247) 6 dB Channel Bandwidth.
6. (15.247) Processing Gain.
7. (15.207) Power Line Conducted Emissions.

4.0 Test Configuration

RF antenna output tests such as Bandwidth, Spurious/Harmonics, Power output, Power Spectral Density, and Processing Gain, were taken with the transmitter antenna connector feeding directly into the spectrum analyzer or power meter. No external attenuators were used, however the analyzer's internal attenuator was adusted to prevent overloading of the front end.

Field strength measurements were taken with the transmitter feeding a 21 dBi gain parabolic dish antenna aimed at the receiving antenna. Full power was developed at the output since a duplex link was not established.

PEAK POWER TEST RESULTS

Limit: 1 watt (30 dBm)

Readings from RF peak power meter (Carrier Modulated):

2412 MHz - +25.3 dBm

2452 MHz - +25.2 dBm

POWER SPECTRAL DENSITY

Limit: 8 dBm
Resolution Bandwidth: 3 kHz
Average Time Interval: 1 second/3 kHz

Actual Time Interval used
for testing: 1.5 seconds/3 kHz

Readings from spectrum analyzer:

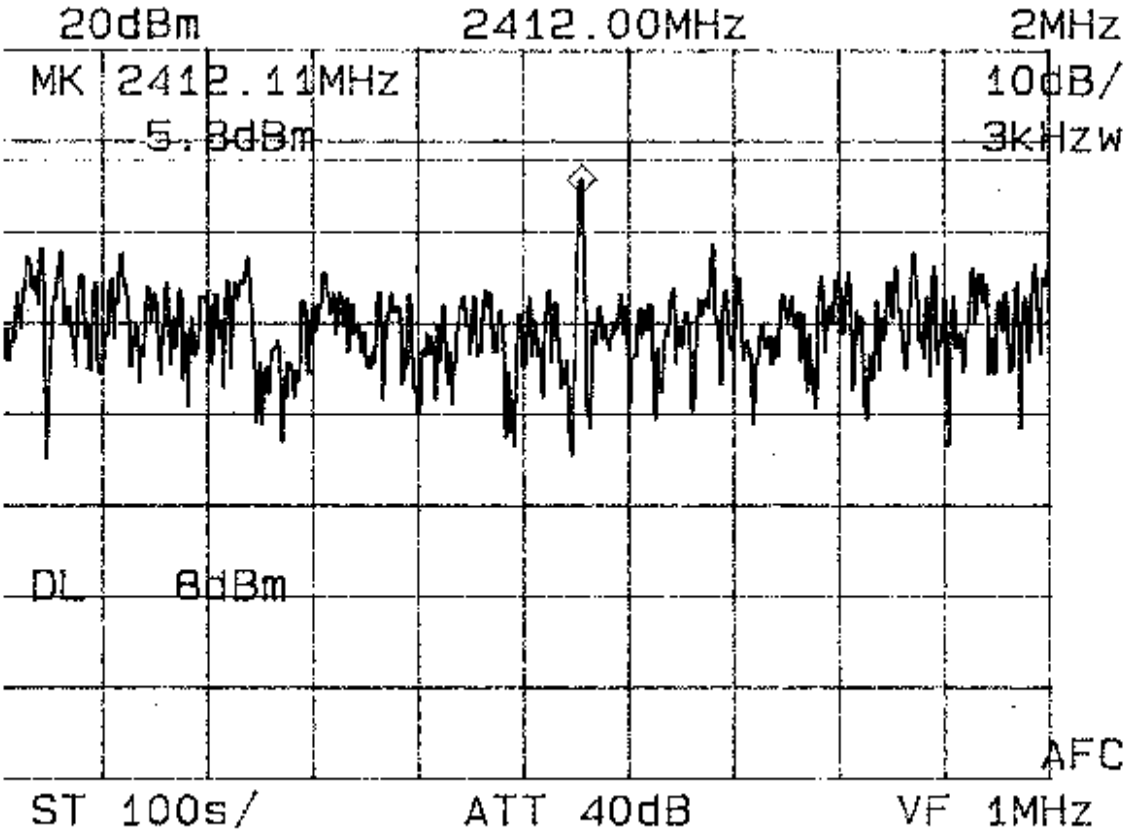
2412 MHz - +5.8 dBm

2452 MHz - +5.8 dBm

SEE FOLLOWING 2 PLOTS

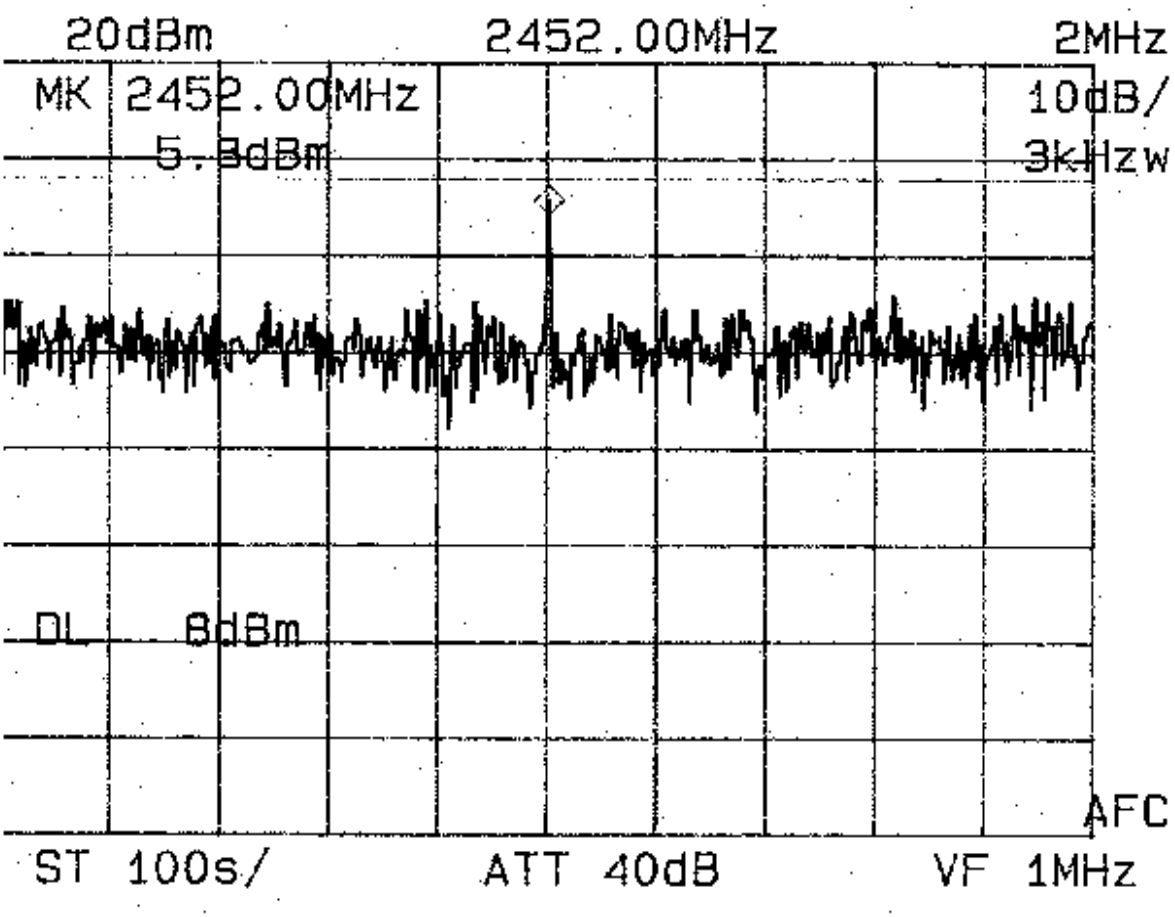
SPECTRAL POWER DENSITY LEVEL

MODULATED **2 MHZ SPAN** **3 KHZ BW**



SPECTRAL POWER DENSITY LEVEL

MODULATED **2 MHZ SPAN** **3 KHZ BW**



6 dB Channel Bandwidth

Minimum 6 dB BW: 500 kHz
RBW Setting on S.A.: 100 kHz

Readings from spectrum analyzer:

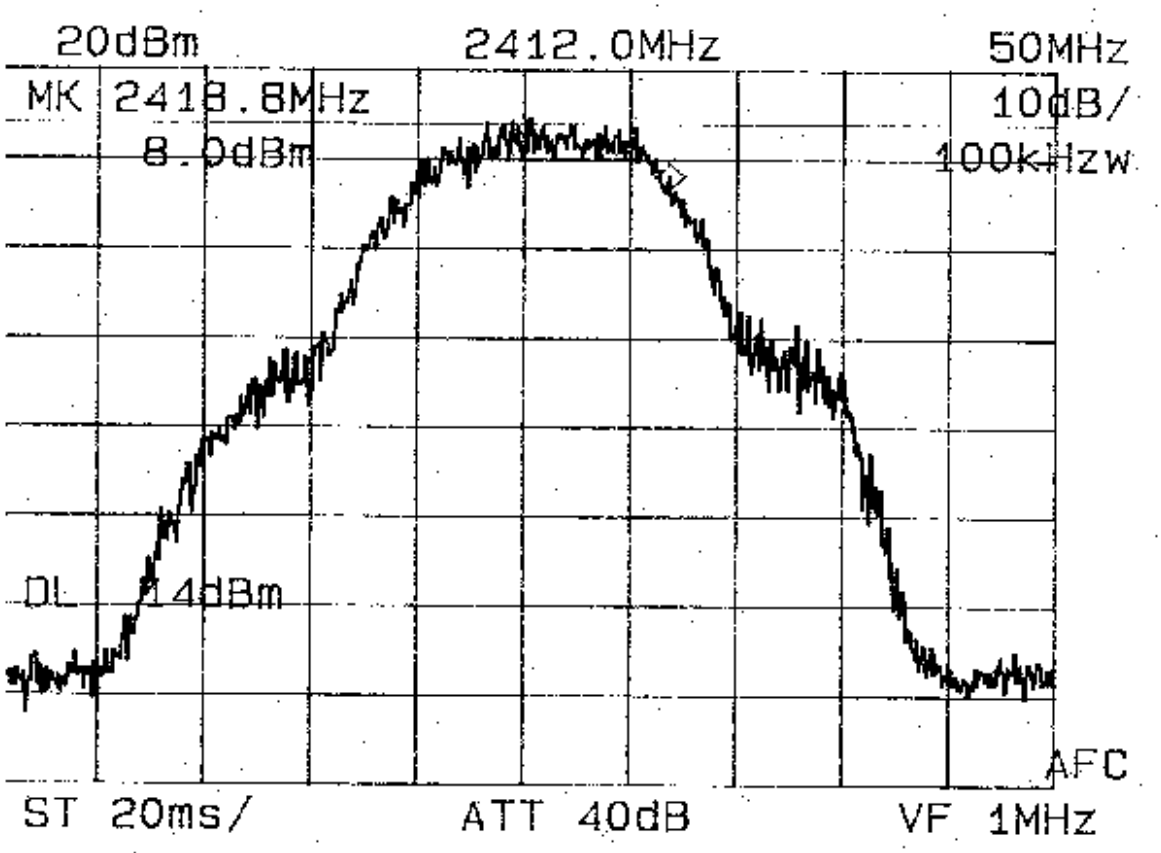
2412 MHz - 11.9 MHz

2452 MHz - 11.4 MHz

SEE FOLLOWING 2 PLOTS

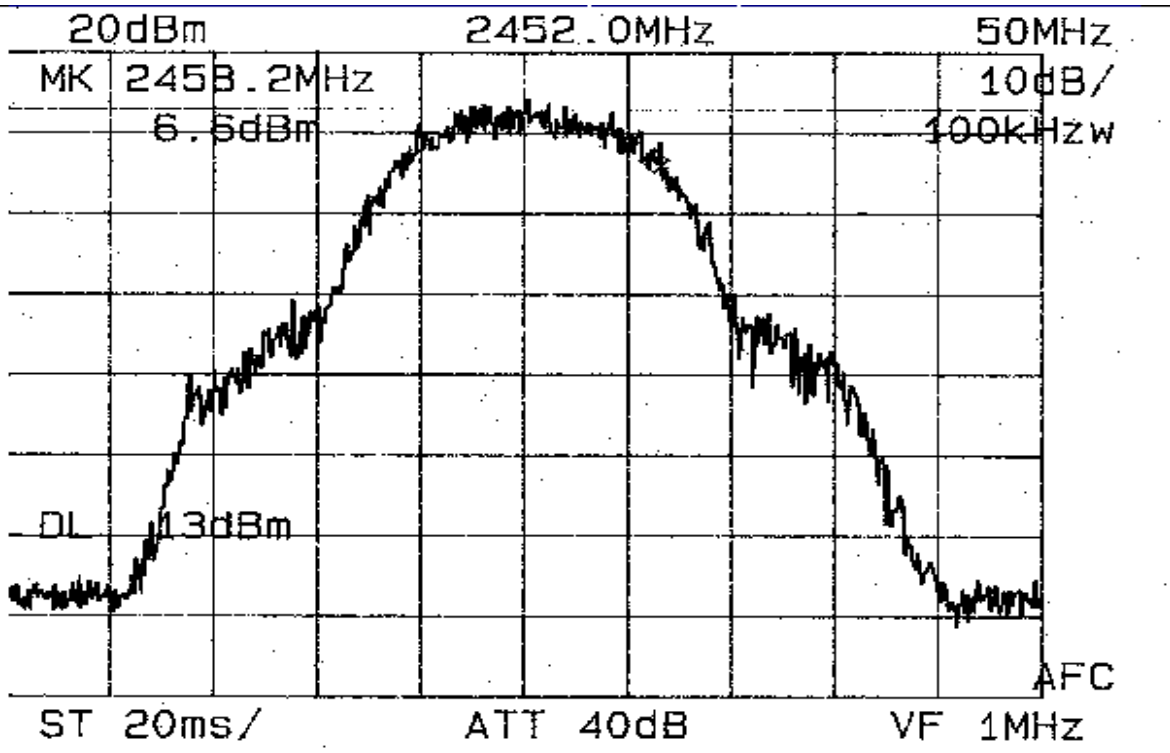
6 dB POWER BANDWIDTH MEASUREMENT

MODULATED **50 MHZ SPAN** **100 KHZ BW**



6 dB POWER BANDWIDTH MEASUREMENT

MODULATED **50 MHZ SPAN** **100 KHZ BW**



RF ANTENNA CONDUCTED SPURIOUS/HARMONICS EMISSIONS

Limit: 20 dB below Carrier Level
RBW Setting on S.A.: 100 kHz

SEE FOLLOWING 2 PLOTS & DATA TABLES

FCC PART 15.247 - CONDUCTED SPURIOUS EMISSIONS

Frequency of Carrier = 2412 MHz
Limit = **20 dBc**

TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

COMPONENT	FREQUENCY (MHZ)	RESULT (dB FROM PEAK)
SPURIOUS	1620.00	- 63
HARMONIC	4824.00	- 52
HARMONIC	7236.00	- 63
HARMONIC	9648.00	- 67
HARMONIC	12060.00	- 68
HARMONIC	14472.00	- 70
HARMONIC	16844.00	- 73
HARMONIC	19296.00	- 74
HARMONIC	21708.00	- 76
HARMONIC	24120.00	- 77

FCC PART 15.247 - CONDUCTED SPURIOUS EMISSIONS

Frequency of Carrier = 2452 MHz
Limit = 20 dBc

TEST RESULTS

LIMIT: -20 dB FROM PEAK CARRIER

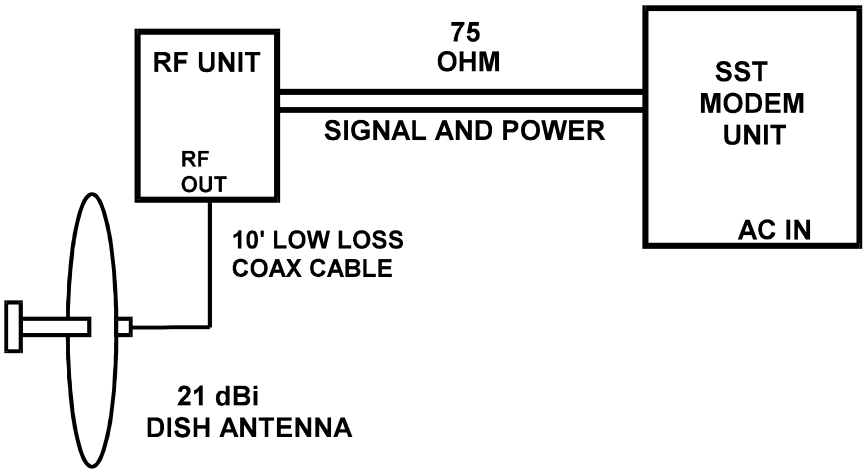
COMPONENT	FREQUENCY (MHZ)	RESULT (dB FROM PEAK)
SPURIOUS	1675.00	- 61
HARMONIC	4904.00	- 55
HARMONIC	7356.00	- 63
HARMONIC	9808.00	- 67
HARMONIC	12260.00	- 69
HARMONIC	14712.00	- 70
HARMONIC	17164.00	- 75
HARMONIC	19616.00	- 77
HARMONIC	22068.00	- 76
HARMONIC	24520.00	- 77

4.0 Test Configuration

RADIATED EMISSIONS

The EUT was set up on the center of the test table, in a manner which follows the general guidelines of ANSI C63.4, Section 6 "**General Operating Conditions and Configurations**".

This is described below:



5.0 Conducted Emissions Scheme

The EUT is placed on an 80 cm high 1 X 1.5 m non-conductive table. Power to the CPU is provided through a Solar Corporation 50 Ω/50 μH Line Impedance Stabilization Network bonded to a 2.2 X 2 meter horizontal ground plane, and a 2.2 X 2 meter vertical ground plane. The LISN has its AC input supplied from a filtered AC power source. A separate LISN provides AC power to the peripheral equipment. I/O cables are moved about to obtain maximum emissions.

The 50 Ω output of the LISN is connected to the input of the spectrum analyzer and emissions in the frequency range of 450 kHz to 30 MHz are searched. The detector function is set to quasi- peak and the resolution bandwidth is set at 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth for final measurements. All emissions within 20 dB of the limit are recorded in the data tables.

6.0 Radiated Emissions Scheme

The EUT is placed on an 80 cm high 1 X 1.5 meter non-conductive motorized turntable for radiated testing on the 3-meter open area test site. The emissions from the EUT are measured continuously at every azimuth by rotating the turntable. Guided horn and log periodic broadband antennas are mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna is varied between 1 and 4 meters. Both the horizontal and vertical field components are measured.

The RF spectrum is searched from 30 MHz - 24.000 GHz.

The output from the antenna is connected to the input of the preamplifier. The preamp out is connected to the spectrum analyzer. The detector function is set to **Peak**. The resolution bandwidth of the spectrum analyzer is set at 120 kHz, for the frequency range of 30-1000 MHZ, and 1 MHz for the range of 1 GHz-24 GHz. A 10 Hz video BW setting is used to average readings above 1 GHz. All emissions within 20 dB of the limit are recorded in the data tables.

To convert the spectrum analyzer reading into a quantified E-field level to allow comparison with the FCC limits, it is necessary to account for various calibration factors. These factors include cable loss (CL) and antenna factors (AF). The AF/CL in dB/m is algebraically added to the Spectrum Analyzer Voltage in dbμV to obtain the Radiated Electric Field in dBμV/m. This level is then compared with the FCC limit.

Example:

Spectrum Analyzer Volt: VdBuV

Composite Factor: AF/CLdB/m

Electric Field: EdBμV/m = VdBμV + AF/CLdB/m
Linear Conversion: EuV/m = Antilog (EdBμV/m/20)

FCC 15.209 RADIATED EMISSIONS DATA

FCC ID: NK4-2023336988

CLIENT: IO WAVE, INC.
EUT: IO LINK 4.0 TX

CARRIER: 2412 MHZ

FREQ	POL	AVRG SPEC A	AF/CL	PREAMP	E-FIELD	E-FIELD	LIMIT	AVRG MRGN
MHz	H/V	dBuV	dB/m	GAIN	dBuV/m	uV/m	uV/m	dB
4824.00	V	33.0	37.0	-25	45.0	177.8	500.0	-9.0
7236.00	V	27.0	39.0	-25	41.0	112.2	500.0	-13.0
12060.00	H	22.0	42.0	-25	39.0	89.1	500.0	-15.0
14472.00	H	19.0	44.0	-25	38.0	79.4	500.0	-16.0
19296.00	V	20.0	36.0	-25	31.0	35.5	500.0	-23.0

FCC 15.209 RADIATED EMISSIONS DATA

FCC ID: NK4-2023336988

CLIENT: IO WAVE, INC.
EUT: IO LINK 4.0 TX

CARRIER: 2452 MHZ

FREQ	POL	AVRG SPEC A	AF/CL	PREAMP	E-FIELD	AVRG E-FIELD	LIMIT	MRGN
MHz	H/V	dBuV	dB/m	GAIN	dBuV/m	uV/m	uV/m	dB
1675.00	V	39.0	29.0	-25	43.0	141.3	500.0	-11.0
4904.00	V	35.0	37.0	-25	47.0	223.9	500.0	-7.0
7356.00	V	29.0	39.0	-25	43.0	141.3	500.0	-11.0
12260.00	H	25.0	42.0	-25	42.0	125.9	500.0	-12.0
19616.00	V	27.0	36.0	-25	38.0	79.4	500.0	-16.0
22068.00	H	25.0	37.0	-25	37.0	70.8	500.0	-17.0

FCC CLASS B CONDUCTED EMISSIONS DATA

FCC ID: NK4-2023336988

CLIENT: IO WAVE, INC.

EUT: IO LINK 4.0 TX

CARRIER: 2452 MHZ

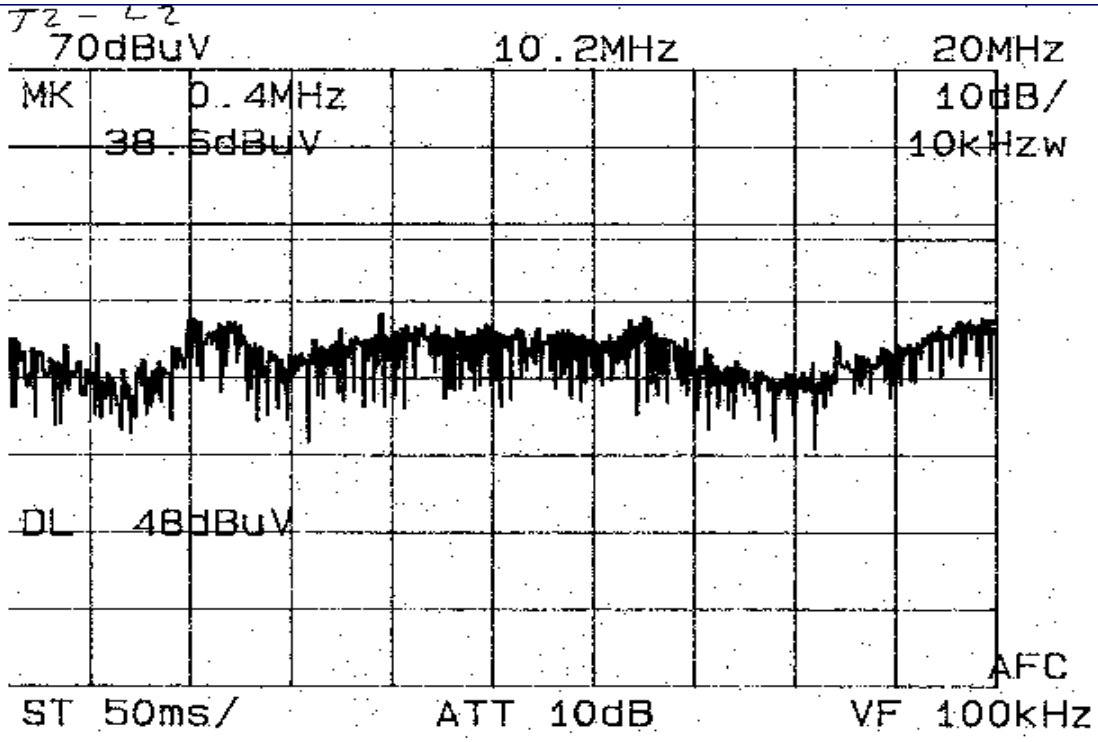
LINE 1 - NEUTRAL

FREQ MHz	VOLTAGE dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
3.5	37.6	75.9	250	-10.4
5.2	38.4	83.2	250	-9.6
11.2	37.4	74.1	250	-10.6
17.1	37.8	77.6	250	-10.2
20.1	37.6	75.9	250	-10.4

LINE 2 - PHASE

FREQ MHz	VOLTAGE dBuV	VOLTAGE uV	FCC LIMIT uV	MARGIN dB
0.458	38.6	85.1	250	-9.4
4.3	37.6	75.9	250	-10.4
8.2	38.4	83.2	250	-9.6
13.2	38.1	80.4	250	-9.9
20.1	37.8	77.6	250	-10.2

A.C. LINE-CONDUCTED EMISSIONS - L1



A.C. LINE-CONDUCTED EMISSIONS - L2

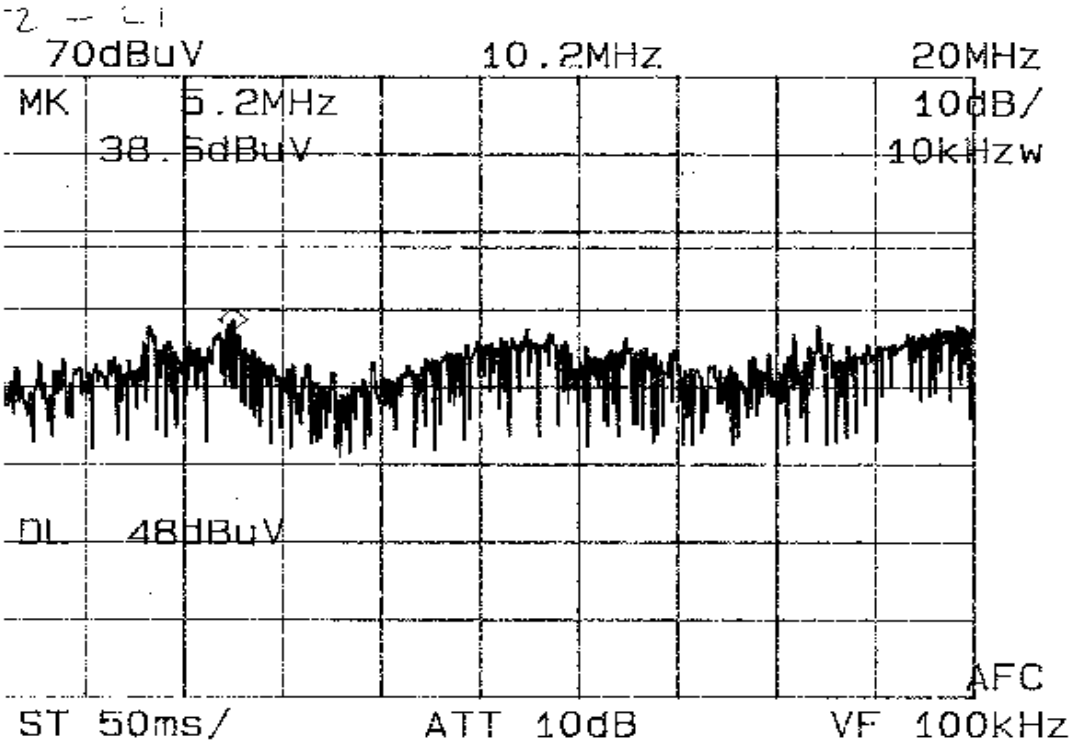

70dBuV
10.2MHz
20MHz
MK
5.2MHz
10dB/
38.5dBuV
10kHzw
DL 48dBuV
AFC
ST 50ms/
ATT 10dB
VF 100kHz

Table 1

Support Equipment

Parabolic Dish Antenna - Comsat Model P-24A24N-1 (2.3-2.5 GHz)

- S/N: 224576

- Gain = 21 dBi

Table 2

Interface Cables Used

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7 ft., dual 75 ohm coaxial cables are used to connect the indoor modem unit to the outside RF transmitter unit.

A 10 ft., 1/4" semirigid 50 ohm coax line is used to connect the output of the RF unit to the dish antenna.

Table 3

Measurement Equipment Used

The following equipment is used to perform measurements:

HP 435A RF Peak Power Meter	- Serial No. 1362016
EMCO Model 3110 Biconical Antenna	- Serial No. 1619
Antenna Research MWH-1825B Horn Antenna	- Serial No. 1005
EMCO Model 3115 Ridged Horn Antenna	- Serial No. 3007
HP 8348A Preamplifier	- Serial No. 197-2564A
Solar 8012-50-R-24-BNC LISN	- Serial No. 924867
Solar 8012-50-R-24-BNC LISN	- Serial No. 927230
Tektronix R3272 Spectrum Analyzer	- Serial No. 6-95-1124
4 Meter Antenna Mast	
Motorized Turntable	
Heliax FSJ1-50A 1/4" Superflex Coax Cable (12 Ft.)	

EXHIBIT 1

EUT PHOTOGRAPHS

EXHIBIT 2

SCHEMATIC DIAGRAM

EXHIBIT 3

USER MANUAL